CHROMOSOME NUMBERS IN COMPOSITAE FROM PAKISTAN[1]

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ABSTRACT

Chromosome numbers of 82 taxa, belonging to 48 genera in ten tribes of the family Compositae, are reported from Pakistan. The chromosome numbers of 13 taxa are reported for the first time, including one new generic count (for *Grantia*) and a new base number ($x = 10$) in *Sonchus*. The new counts are as follows: $n = 6$ for *Launaea tomentella*; $n = 7$ for *Pulicaria gnaphalodes*; $n = 8$ for *Cephalorrhynchus picridiformis*; $n = 9$ for *Artemisia salsolioides*, *Conyza stricta* var. *pinnatifida*, *Grantia aucheri*, *Heteropappus altaicus* var. *canescens*, *Launaea oligocephala*, and *Phagnalon pycnophyllon*; $n = 10$ for *Blumea bovei* and *Sonchus lacnocephalus*; and $n = 14$ for *Scorzonera koelpinioides* and *Scorzonera tortuosissima*. The chromosomal counts for 31 other taxa are new for the flora of Pakistan.

Compositae comprise approximately 20,000 species and about 40% of these have been investigated cytologically (Solbrig, 1977). Very little cytological research has been carried out on the family in Pakistan, where to date chromosome number for only 65 (i.e., ca. 11.0%) of the ca. 604 native species (Ali, 1978) for the family have been counted (Baquar & Askari, 1970; Khatoon & Ali, 1988; Razaq et al., 1988). The present contribution records the chromosome numbers for 82 taxa in 48 genera.

MATERIALS AND METHODS

Meiotic material consisting of immature capitula, collected mostly in the wild (those which were cultivated are specified in Table 1), was fixed in acetic alcohol (1 : 3) for 24 hr. and stored at −4°C. The slides were prepared by conventional squash technique using aceto- or propionic-carmine. Counts were made from pollen mother cells, except in *Dyssodia tenuiloba*, where both somatic and gametic counts were made.

For mitosis, root tips from germinating seeds were pretreated with 8-hydroxyquinoline for 4 hr., fixed in acetic alcohol (1 : 3) for 1 hr., hydrolysed in 1 N HCl for 6–12 min. and squashed in 1.8% aceto-orcein.

Photomicrographs were taken from temporary mounts, in all cases. Later on slides were made permanent in euparal or Canada balsam.

OBSERVATIONS AND RESULTS

A total of 140 chromosomal counts on plants representing 82 taxa belonging to 48 genera of Compositae have been determined. Counts for 13 taxa are reported for the first time, as they were not found to be reported in IPCN (Fedorov, 1974; Goldblatt, 1981, 1984, 1985, 1988; Moore, 1973, 1974; Ornduff, 1967). The classification adopted here follows that of Heywood et al. (1977).

DISCUSSION

Cytologically, Vernonieae are the least known tribe in the family, with fewer than 100 (out of 1450) species so far counted (Mathew & Mathew, 1983). Available cytological data on the genus *Vernonia* (Fedorov, 1974; Jones, 1974; Mathew & Mathew, 1976; Gill, 1978; Keil & Pinkava, 1979; Gupta & Gill, 1979) reveal that species of this genus are based on $x = 9$, 10, and 17. Two of the four species of *Vernonia*, the only genus of Vernonieae in Pakistan (Stewart, 1972), were examined. According to Jones (1977), Old World *Vernonia* have $x = 9$ or 10 and a little polyploidy.

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TABLE 1. Chromosome numbers in Compositae. K.U. = Karachi University; D. G. Khan = town of Dera Ghazi Khan.

Taxon	Chromosome number *n*	Basic number *x*	Voucher
Tribe Eupatorieae			
**Ageratum conyzoides* L. (Fig. 1)	10	10	Sialkot: *Ghafoor 4311*
**Ageratum houstonianum* Mill. (cultivated)	20		K.U. Campus: *Siddiqui 43*
Tribe Vernonieae			
Vernonia cinerascens Sch. Bip.	20	10	K.U. Campus: *Moin. 36*
Vernonia cinerea (L.) Less.	9	9	Kashmir: *T. Ali 112*; Jhelum: *Ghafoor 4278*; Sargodha: *T. Ali 1691*
Tribe Astereae			
Conyza aegyptiaca Ait.	9	9	D. G. Khan: *Ghafoor 3652*
Conyza bonariensis (L.) Cronquist	27		K.U. Campus: *Ahsan 70*; Kathore: *Jahan 75*; Hasan Abdal: *Ghafoor 2270*
**Conyza japonica* (Thunb.) Less.	9		Sargodha: *T. Ali 1655*
***Conyza stricta* Willd. var. *pinnatifida* (D. Don) Kit.	9		Kashmir: *T. Ali 232*
Heteropappus altaicus (Willd.) Novopokr. (Fig. 2)	9	9	Dir: *Ghafoor 2324*; Gilgit: *Omer 2412, 2304, 2305*
***Heteropappus altaicus* (Willd.) Novopokr. var. *canescens* (Nees) Serg. (Fig. 3)	9		Chitral: *Ghafoor 3224*
Heteropappus holohermaphroditus Grierson	9		Quetta: *T. Ali 1414*; D. G. Khan: *Ghafoor 3643*
Myriactis wallichii Less.	18	18	Rawalpindi: *Ghafoor 4119*
Tribe Inuleae			
***Blumea bovei* (DC.) Vatke (Fig. 4)	10	10	Makran: *T. Ali 943*
Blumea lacera DC.	10		K.U. Campus: *Siddiqui 8*
Blumea obliqua (L.) Druce	10		K.U. Campus: *Siddiqui 55, 58*
Gnaphalium luteo-album L.	7	7	Dir: *Ghafoor 2487*; Swat: *Ghafoor 3351*
***Grantia aucheri* Boiss. (Fig. 5)	9	9	Makran: *Omer 2118*
**Inula cuspidata* (DC.) C. B. Clarke	10	10	Hazara: *Omer 2791*
Iphiona grantioides (Boiss.) Anderb. (Fig. 6)	9	9	Makran: *Omer 2052, T. Ali 905*; Safari Park, Karachi: *Siddiqui 62*
Phagnalon niveum Edgew.	9	9	Hazara: *Omer 2262*; D. G. Khan: *Ghafoor 3700*
***Phagnalon pycnophyllon* Rech.f. (Fig. 7)	9		Chitral: *Ghafoor 3157*
Pluchea arguta Boiss. (Fig. 8)	10	10	Makran: *T. Ali 877*
Pluchea indica (L.) Less.	30		Makran: *T. Ali 892*; K.U. Campus: *Jahan 7, 8, 9*
Pluchea lanceolata (DC.) Clarke	10		K.U. Campus: *Jahan 37*
Pulicaria angustifolia DC.	7	7	K.U. Campus: *Siddiqui 40, 49*
***Pulicaria gnaphalodes* (Vent.) Boiss. (Fig. 9)	7		Quetta: *T. Ali 1243*
Pulicaria hookeri Jafri	7		Super Highway, Karachi: *T. Ali 1437*
Tribe Heliantheae			
**Bidens biternata* (Lour.) Merr. & Sherff	36	12	Hazara: *Omer 2233*
Blainvillea acmella (L.) Philipson	17	17	K.U. Campus: *Moin. 41*
Coreopsis atkinsoniana Douglas (cultivated)	12	12	Malir: *Moin. 20*
**Coreopsis lanceolata* L. (cultivated) (Fig. 10)	10	10	K.U. Campus: *Jahan 14, 25*

TABLE 1. Continued.

Taxon	Chromosome number *n*	Basic number *x*	Voucher
**Cosmos bipinnatus* Cav. (cultivated)	12	12	K.U. Campus: *Siddiqui 44*
**Dahlia variabilis* (Willd.) Desf. (cultivated)	32	16	K.U. Campus: *Jahan 15*
Eclipta prostrata (L.) L.	11	11	K.U. Campus: *Siddiqui 9*; Sajawal: *Ahsan 18*; Thatta: *Siddiqui 106, 123*; Khushab: *Ghafoor 3835*; Swat: *Ghafoor 3970*
Flaveria trinervia (Spreng.) C. Mohr	18	18	Kathore: *Jahan 85*
Gaillardia pulchella Fouger (cultivated)	17	17	K.U. Campus: *Siddiqui 24*
**Galinsoga parviflora* Cav.	8	8	Kashmir: *T. Ali 312*; D. G. Khan: *Ghafoor 3650*
**Helianthus annus* L. (cultivated)	17	17	K.U. Campus: *Moin. 9*
**Parthenium hysterophorus* L.	18	18	Gujrat: *Ghafoor 4308*
**Rudbeckia maxima* Nutt. (cultivated)	18	18	K.U. Campus: *Jahan 10*
Tridax procumbens L.	18	9	K.U. Campus: *Siddiqui 26*
**Xanthium strumarium* L.	18	18	K.U. Campus: *Razaq 122*; Ghotki: *Ghafoor 3512*; Kashmir: *T. Ali 198*; Kathore: *Jahan 74*
Zinnia elegans Jacq. (cultivated)	12	12	K.U. Campus: *Moin. 5*
Tribe Tageteae			
**Dyssodia tenuiloba* (DC.) B. L. Robinson (cultivated)	12	12	K.U. Campus: *Ahsan 55*
Dyssodia tenuiloba (Fig. 11)	$2n = 24$		K.U. Campus: *Jahan 51*
**Tagetes minuta* L. (Fig. 12)	24	12	Jhelum: *Ghafoor 3886*; Kashmir: *T. Ali 349*
Tribe Senecioneae			
Hertia intermedia (Boiss.) Kuntze	10	10	Quetta: *T. Ali 1237*
**Senecio analogus* DC.	20	10	Swat: *Ghafoor 3451*
Senecio desfontanei Druce	10		Baltistan: *Omer 2436*; Chitral: *Ghafoor 2551*; Dir: *Ghafoor 2489*
Senecio krascheninnikovii Schischk.	10		Chitral: *Ghafoor 2741*; Gilgit: *Omer 2520*
Tribe Anthemideae			
Achillea millefolium L.	9	9	Gilgit: *Omer 2326*; Kashmir: *T. Ali 559*
**Anthemis cotula* L.	9	9	K.U. Campus: *Jahan 36*; Kashmir: *T. Ali 511*; Chitral: *Ghafoor 3243, 2976, 2518*
**Artemisia capillaris* Thunb. (Fig. 13)	8	8	Sargodha: *Ghafoor 3801*
**Artemesia persica* Boiss. (Fig. 14)	9	9	Chitral: *Ghafoor 3225, 2571, 2581*
**Artemisa rutaefolia* Spreng. (Fig. 15)	9		Chitral: *Ghafoor 3219*
***Artemisia salsoloides* Willd. (Fig. 16)	9		Gilgit: *Omer 2430*
**Artemisia siversiana* Willd.	9		Chitral: *Ghafoor 3111*
**Handelia trichophylla* (Schrenk) Heimerl	9	9	Chitral: *Ghafoor 3234*
Tanacetum fruticulosum Ledeb. (Fig. 17)	9	9	Gilgit: *Omer 2548*
**Tripleurospermum disciforme* (C. A. Mey.) Sch. Bip.	9	9	Chitral: *Ghafoor 2846*

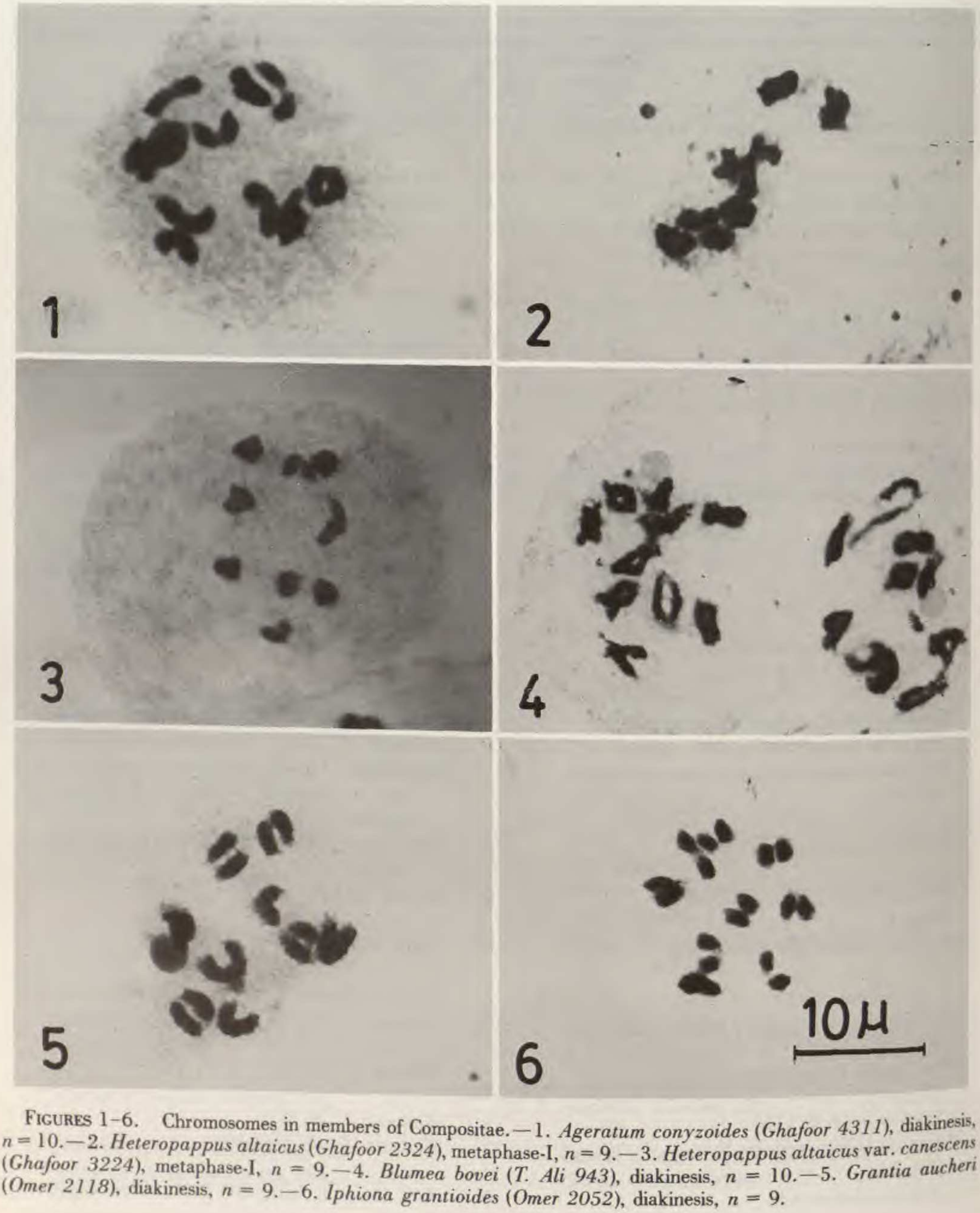
TABLE 1. Continued.

Taxon	Chromosome number n	Basic number x	Voucher
Tribe Cynareae			
Centaurea cyanus L. (cultivated)	12	12	K.U. Campus: *Jahan 11*
**Oligochaeta ramosa* (Roxb.) Wagenitz	14	14	Darsanochano: *Siddiqui 82*; Makran: *Omer 2090, T. Ali 993*
Tribe Lactuceae			
***Cephalorrhynchus picridiformis* (Boiss.) Tuisl (Fig. 18)	8	9	Quetta: *T. Ali 1394*
**Cichorium intybus* L.	9	9	Thatta: *Siddiqui 105*
**Crepis multicaulis* Ledeb. subsp. *congesta* (Regel) Babc.	5	5	Swat: *Ghafoor 3376*
Crepis sancta (L.) Babc.	5		Chitral: *Ghafoor 2997*
Lactuca dissecta D. Don	8	8	Chitral: *Ghafoor 2951*
**Lactuca serriola* L.	9	9	Attock: *Ghafoor 3888*; Zhob: *T. Ali 1059*
**Launaea capitata* (Spreng.) Dandy	9	9	Makran: *T. Ali 1492*
Launaea nudicaulis (L.) Hook.f.	9		Rawalpindi: *Ghafoor 4175*; Faisalabad; *Ghafoor 4377*; Makran: *T. Ali 708*; Kathore: *Jahan 63*; Sajawal: *Ahsan 15*; Thatta: *Siddiqui 98, 114, 118, 124*
***Launaea oligocephala* (Hausskn. & Bornm. ex Bornm.) Bornm. (Fig. 19)	9		Makran: *T. Ali 953*
**Launaea procumbens* (Roxb.) Ramayya & Rajagopal (Fig. 20)	9		Makran: *Omer 2097, 2040*; Hasilpur: *Ghafoor 3582*
Launaea remotiflora (DC.) Amin ex Rech.f.	9		Safari Park, Karachi: *Siddiqui 71*; K.U. Campus: *Moin. 6*; Kashmir: *T. Ali 271*; Bahlolpur: *Ghafoor 4307*
**Launaea resedifolia* (L.) Kuntze	8	8	Safari Park, Karachi: *Ahsan 39*; Bahawalpur: *Ghafoor 3574*
**Launaea secunda* (C. B. Clarke) Hook.f.	9	9	Chitral: *Ghafoor 2410*
***Launaea tomentella* Rech.f. (Fig. 21)	6	6	Zhob: *T. Ali 1167*
Picris hieracioides L.	5	5	Chitral: *Ghafoor 2583*
***Scorzonera koelpinioides* Rech.f. (Fig. 22)	14	7	Makran: *T. Ali 992*
***Scorzonera tortuosissima* Boiss. (Fig. 23)	14		Makran: *T. Ali 991*
Sonchus asper (L.) Hill	9	9	Kashmir: *T. Ali 578*
***Sonchus lachnocephalus* Rech.f. (Fig. 24)	10	10	Kashmir: *T. Ali 174, 493*
Sonchus oleraceus L.	16	8	K.U. Campus: *Jahan 29*; D. G. Khan: *Ghafoor 3657*
Sonchus wightianus DC.	9	9	Kashmir: *T. Ali 331*; Rawalpindi: *T. Ali 1955*

* Count new to flora of Pakistan.
** Count new to science.

Our counts for *V. cinerascens* ($n = 20$) and *V. cinerea* ($n = 9$) confirm the above statement.

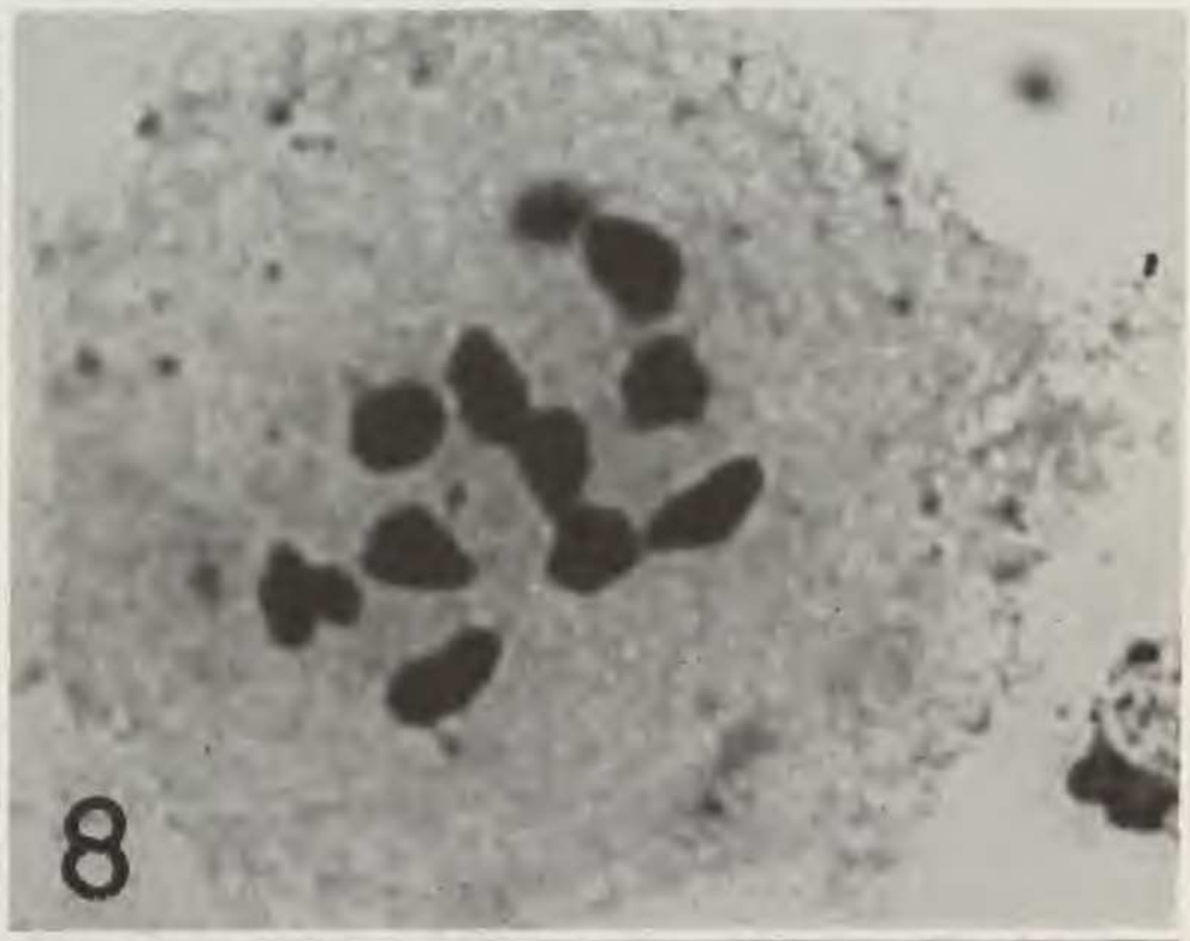
The basic number for various members of Astereae is reported to be $x = 9$ with polyploidy (Raven et al., 1960; Solbrig et al., 1964, 1969; Anderson et al., 1974). Out of eight taxa of Astereae studied, chromosome counts of all the species except *Myriactis wallichii* are based on $x = 9$. All the species of the genus *Myriactis* are reported to have $n = x = 18$.

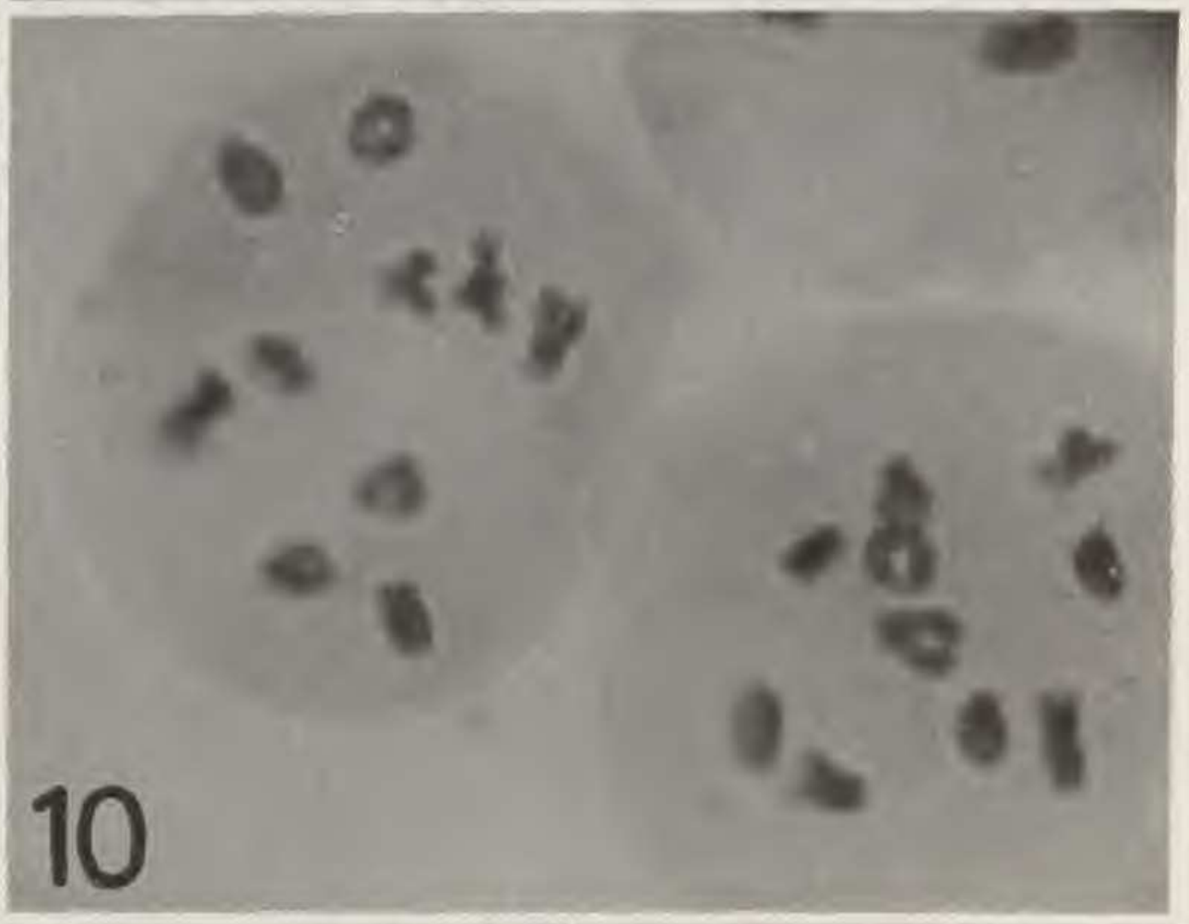


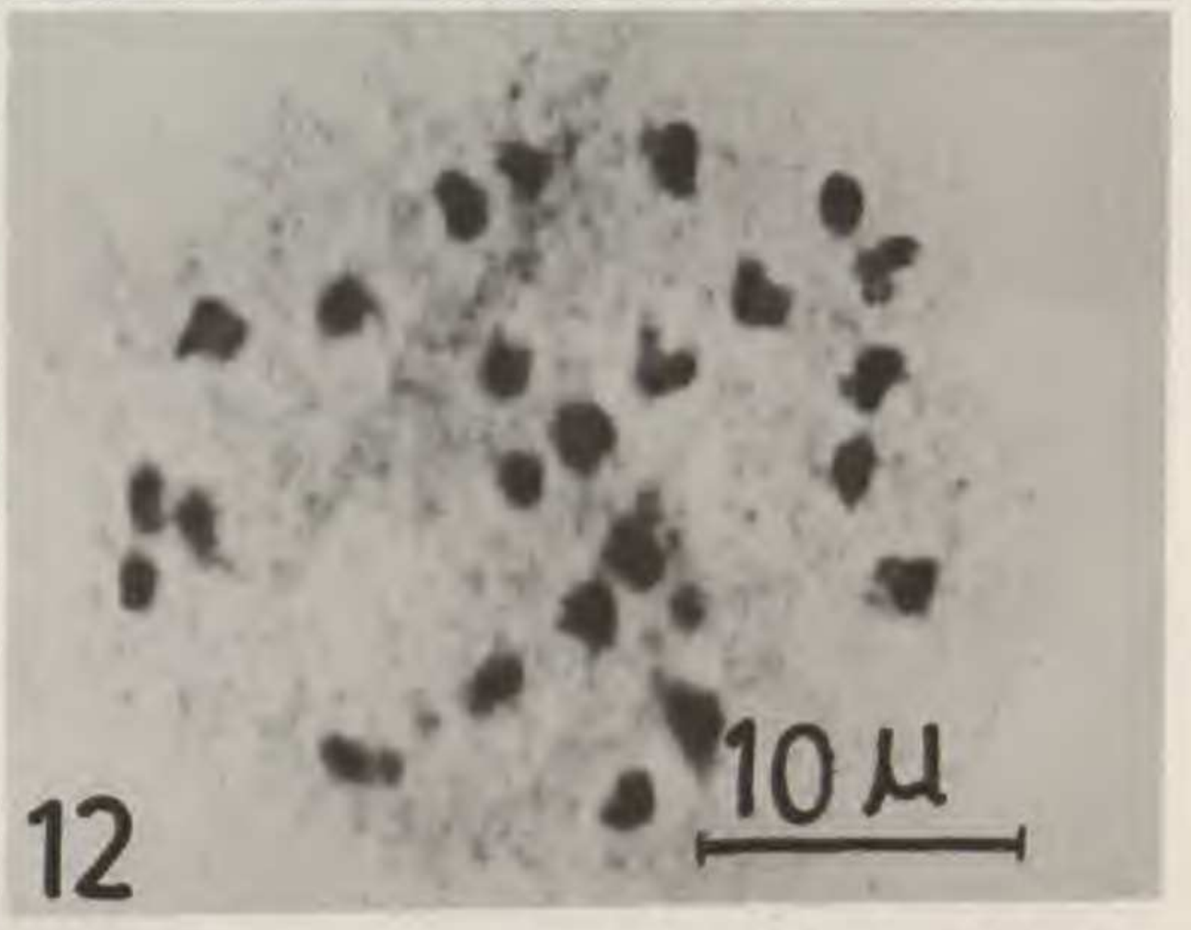
FIGURES 1–6. Chromosomes in members of Compositae.—1. *Ageratum conyzoides* (*Ghafoor 4311*), diakinesis, $n = 10$.—2. *Heteropappus altaicus* (*Ghafoor 2324*), metaphase-I, $n = 9$.—3. *Heteropappus altaicus* var. *canescens* (*Ghafoor 3224*), metaphase-I, $n = 9$.—4. *Blumea bovei* (*T. Ali 943*), diakinesis, $n = 10$.—5. *Grantia aucheri* (*Omer 2118*), diakinesis, $n = 9$.—6. *Iphiona grantioides* (*Omer 2052*), diakinesis, $n = 9$.

The members of tribe Inuleae exhibit a predominance of the basic numbers $x = 9$ and 10 (Merxmuller et al., 1977). In this tribe, we have examined 15 species in eight genera. Of these, four species (belonging to two genera) are based on $x = 7$, four species (belonging to three genera) on $x = 9$, and seven species (belonging to three genera) on $x = 10$. Our data thus agree with Merxmuller et al.'s conclusion (1977). In Senecioneae, the most frequent basic numbers are multiples of ten (Nordenstam, 1977). Our observations on the chromosome numbers of three species of *Senecio* (Table 1) are based on $x = 10$. The count for *S. kraschenninkovii*, $n = 10$, differs from the previous report of $n = 9$ (Khatoon & Ali, 1988).

Chromosome counts have been reported for about



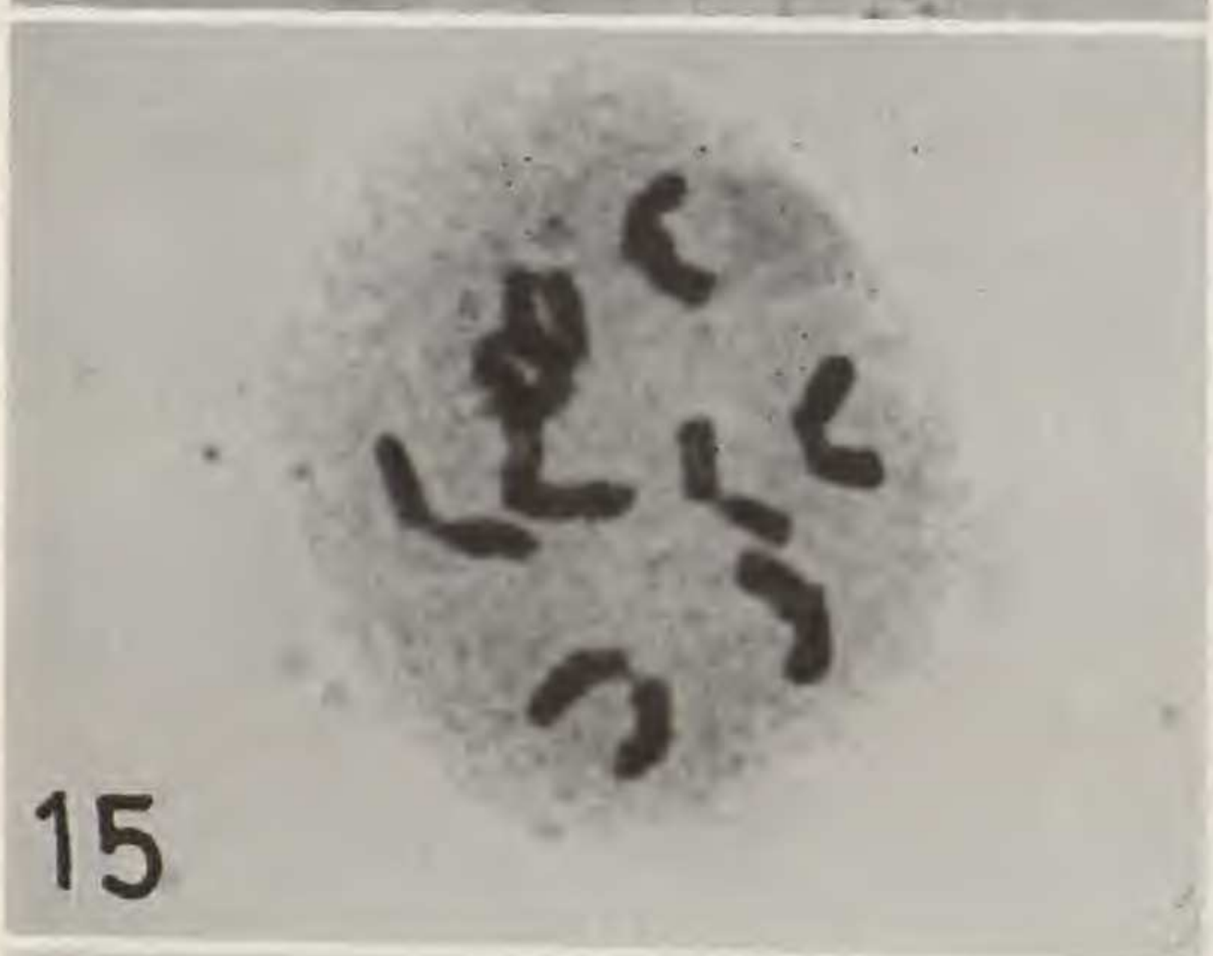


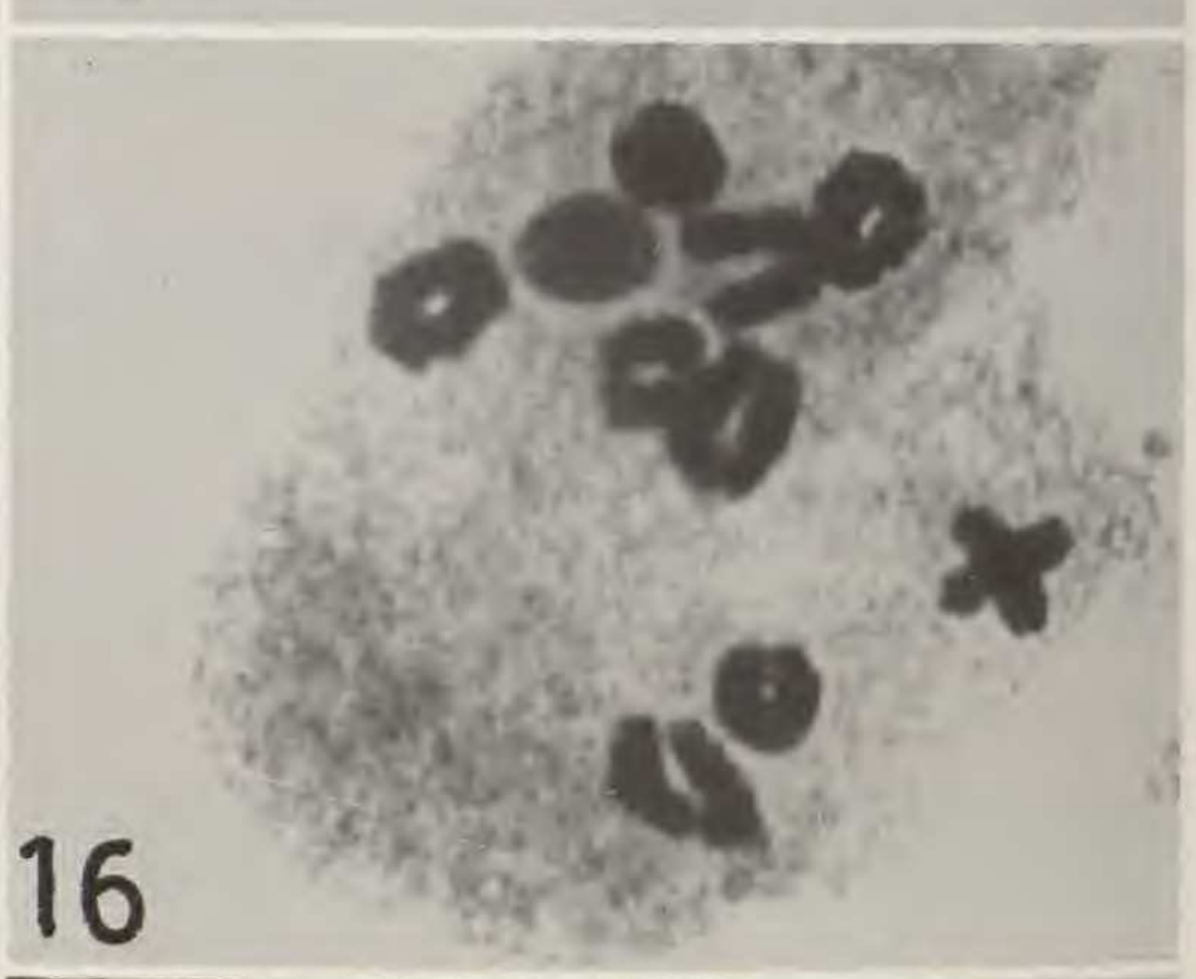


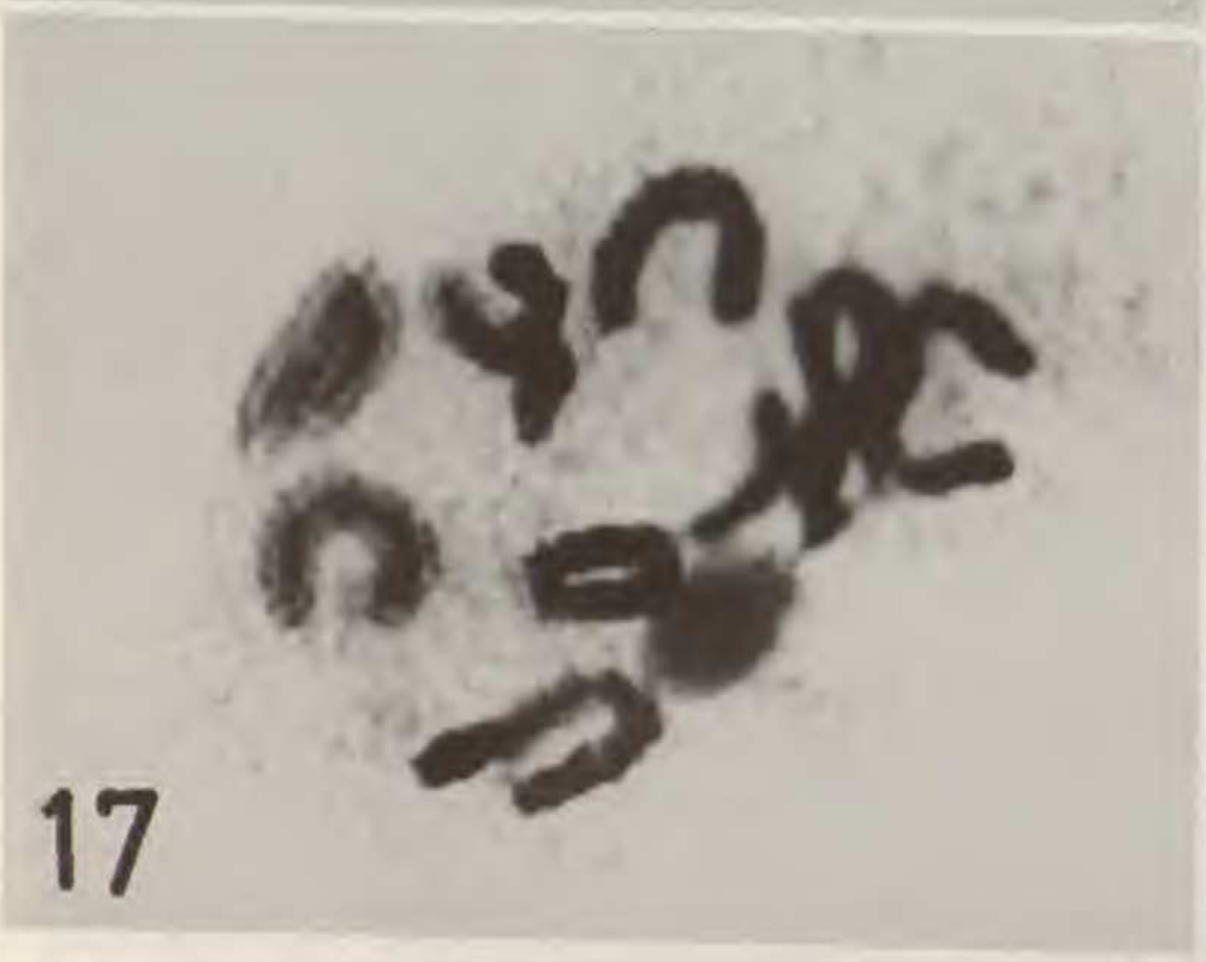
FIGURES 7–12. Chromosomes in members of Compositae.—7. *Phagnalon pycnophyllon* (*Ghafoor 3157*), anaphase-I, $n = 9$.—8. *Pluchea arguta* (*T. Ali 877*), metaphase-I, $n = 10$.—9. *Pulicaria gnaphalodes* (*T. Ali 1243*), diakinesis, $n = 7$.—10. *Coreopsis lanceolata* (*Jahan 14*), diakinesis, $n = 10$.—11. *Dyssodia tenuiloba* (*Ahsan 55*), mitotic metaphase, $2n = 24$.—12. *Tagetes minuta* (*Ghafoor 3886*), diakinesis, $n = 24$.

50% of the genera of Anthemideae (Heywood & Humphries, 1977). Ten of the 11 taxa of Anthemideae examined have $n = 9$; *Artemisia capillaris*, however, has $n = 8$ (Fig. 13), a count contrary to the earlier findings ($2n = 18$: Arano, 1965 and $2n = 36$: Peng & Hsu, 1978). The present report may represent aneuploid variation. The most frequent chromosome number in *Artemisia* is $n = 9$ and probably the basic number for the genus was also $x = 9$ (Stahevitch & Wojtas, 1987).

Chromosome numbers for 21 taxa of Lactuceae are reported here. The count for *Cephalorrhynchus picridiformis* ($n = 8$, Fig. 18) does not agree

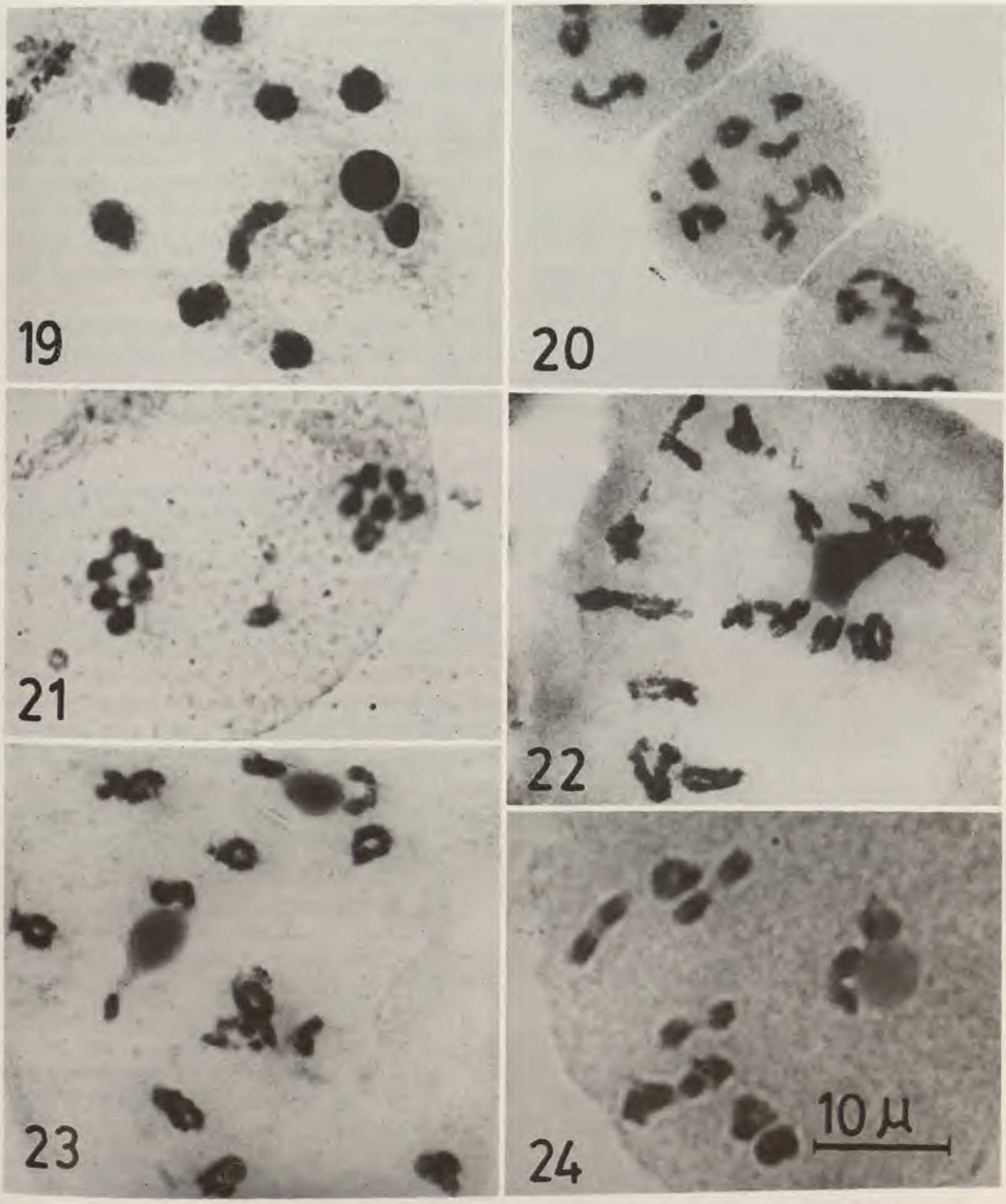






FIGURES 13–18. Chromosomes in members of Compositae.—13. *Artemisia capillaris* (*Ghafoor 3801*), diakinesis, $n = 8$.—14. *Artemisia persica* (*Ghafoor 3225*), diakinesis, $n = 9$.—15. *Artemisia rutaefolia* (*Ghafoor 3219*), diakinesis, $n = 9$.—16. *Artemisia salsoloides* (*Omer 2430*), diakinesis, $n = 9$.—17. *Tanacetum fruticulosum* (*Omer 2548*), diakinesis, $n = 9$.—18. *Cephalorrhynchus picridiformis* (*T. Ali 1394*), diakinesis, $n = 8$.

with basic number $x = 9$, proposed by Darlington & Wylie (1955), for this genus. In *Launaea*, $x = 6$, 7, 8, and 9 are reported. However, $n = 6$ has been reported for *L. asplenifolia* Hook. f. by Sarkar et al. (1975). We have observed the same number for *L. tomentella* (Table 1, Fig. 21). For the genus *Sonchus*, $x = 8$ and 9 are reported. Our count of $n = 10$ for *Sonchus lachnocephalus* (Fig. 24) establishes a new basic number ($x = 10$) for the genus. Chromosomally, the Lactuceae are perhaps the best known tribe in the family. Chromosome numbers are known for 87.0% of the genera of the tribe (Tomb, 1977). Stebbins et al. (1953) proposed $x = 9$ as the ancestral base chromosome number for the tribe, on the basis of its frequency of occurrence and presence in genera considered to be primitive. In the present study ten taxa out of 21 examined are found to be based



FIGURES 19–24. Chromosomes in members of Compositae.—19. *Launaea oligocephala* (*T. Ali 953*), diakinesis, $n = 9$.—20. *Launaea procumbens* (*Omer 2097*), diakinesis, $n = 9$.—21. *Launaea tomentella* (*T. Ali 1167*), metaphase-II, $n = 6$.—22. *Scorzonera koelpinioides* (*T. Ali 992*), diakinesis, $n = 14$.—23. *Scorzonera tortuosissima* (*T. Ali 991*), diakinesis, $n = 14$.—24. *Sonchus lachnocephalus* (*T. Ali 174*), diakinesis, $n = 10$.

on $x = 9$, whereas other taxa are based on $x = 5$, 6, 7, and 8.

LITERATURE CITED

ALI, S. I. 1978. The flora of Pakistan: Some general and analytical remarks. Notes Roy. Bot. Gard. Edinburgh 36: 427–439.

ANDERSON, L. C., D. W. KYHOS, T. MOSQUIN, A. M. POWELL & P. H. RAVEN. 1974. Chromosome numbers in Compositae. IX. *Haplopappus* and other Astereae. Amer. J. Bot. 61: 665–671.

ARANO, H. 1965. The karyotypes and the speciations in subfamily Carduoideae (Compositae) of Japan. XVIII. Jap. J. Bot. 19: 31–67.

BAQUAR, S. R. & S. H. A. ASKARI. 1970. Chromosome numbers in some flowering plants of West Pakistan—II. Genét. Ibér. 22: 41–51.

DARLINGTON, C. D. & A. P. WYLIE. 1955. Chromosome Atlas of Flowering Plants. George Allen & Unwin Ltd., London.

FEDOROV, A. A. (editor). 1974. Chromosome Numbers of Flowering Plants. Otto Koeltz Science Publishers, Germany (reprinted).

GILL, B. S. 1978. Chromosome Number Reports LX. Taxon 27: 229–230.

GOLDBLATT, P. (editor). 1981. Index to Plant Chromosome Numbers 1975–1978. Monogr. Syst. Bot. Missouri Bot. Gard. 5: 1–553.

———. 1984. Index to Plant Chromosome Numbers 1979–1981. Monogr. Syst. Bot. Missouri Bot. Gard. 8: 1–427.

———. 1985. Index to Plant Chromosome Numbers 1982–1983. Monogr. Syst. Bot. Missouri Bot. Gard. 13: 1–224.

———. 1988. Index to Plant Chromosome Numbers 1984–1985. Monogr. Syst. Bot. Missouri Bot. Gard. 23: 1–264.

GUPTA, R. C. & B. S. GILL. 1979. Chromosome Number Reports LXIV. Taxon 28: 401–402.

HEYWOOD, V. H. & C. J. HUMPHRIES. 1977. Anthemideae—Systematic review. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. II. Academic Press, London & New York.

———, J. B. HARBORNE & B. L. TURNER (editors). 1977. The Biology and Chemistry of Compositae, Vols. I and II. Academic Press, London & New York.

JONES, S. B. 1974. Vernonieae (Compositae) chromosome numbers. Bull. Torrey Bot. Club 101: 31–34.

———. 1977. Vernonieae—Systematic review. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. I. Academic Press, London & New York.

KEIL, D. J. & D. J. PINKAVA. 1979. Chromosome Number Reports. LXIII. Taxon 28: 271–273.

KHATOON, S. & S. I. ALI. 1988. Chromosome numbers in Compositae from Pakistan. Candollea 43: 455–462.

MATHEW, A. & P. M. MATHEW. 1976. Studies on South Indian Compositae: Cytology of the genus *Vernonia*. Cytologia 41: 401–406.

MATHEW, P. M. & A. MATHEW. 1983. Studies on the South Indian Compositae V. Cytotaxonomic consideration of the tribes Vernonieae and Eupatorieae. Cytologia 48: 679–690.

MERXMULLER, H., P. LIENS & H. ROESSLER. 1977. Inuleae—Systematic review. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. I. Academic Press, London & New York.

MOORE, R. J. (editor). 1973. Index to Plant Chromosome Numbers for 1967–1971. Regnum Vegetabile 90: 1–539.

———. 1974. Index to Plant Chromosome Numbers for 1972. Regnum Vegetabile 91: 1–108.

NORDENSTAM, B. 1977. Senecioneae and Liabeae—Systematic review. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. II. Academic Press, London & New York.

ORNDUFF, R. (editor). 1967. Index to Plant Chromosome Numbers for 1965. Regnum Vegetabile 50: 1–128.

PENG, C.-I. & C.-C. HSU. 1978. Chromosome numbers in Taiwan Compositae. Bot. Bull. Acad. Sin. 19: 53–66.

RAVEN, P. H., O. T. SOLBRIG, D. W. KYHOS & R. SNOW. 1960. Chromosome numbers in Compositae. I. Astereae. Amer. J. Bot. 47: 124–132.

RAZAQ, Z. A., S. KHATOON & S. I. ALI. 1988. A contribution to the chromosome numbers of Compositae from Pakistan. Pakistan J. Bot. 20: 177–189.

SARKAR, A. K., N. DATTA & U. CHATTERJEE. 1975. Chromosome Number Reports XLVIII. Taxon 24: 367–372.

SOLBRIG, O. T. 1977. Chromosomal cytology and evolution in the family Compositae. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. I. Academic Press, London & New York.

———, L. C. ANDERSON, D. W. KYHOS & P. H. RAVEN. 1969. Chromosome numbers in Compositae VII: Astereae III. Amer. J. Bot. 56: 348–353.

———, ———, ———, ——— & L. RUDENBERG. 1964. Chromosome numbers in Compositae V. Astereae II. Amer. J. Bot. 51: 513–519.

STAHEVITCH, A. E. & W. A. WOJTAS. 1987. Chromosome numbers of some North American species of *Artemisia* (Asteraceae). Canad. J. Bot. 66: 672–676.

STEBBINS, G. L., JR., J. A. JENKINS & M. S. WALTERS. 1953. Chromosomes and Phylogeny in the Compositae, Tribe Cichorieae, Univ. Calif. Publ. Bot. 16: 401–430.

STEWART, R. R. 1972. An annotated catalogue of the vascular plants of West Pakistan and Kashmir. *In:* E. Nasir & S. I. Ali (editors), Flora of Pakistan. Karachi.

TOMB, A. S. 1977. Lactuceae—Systematic review. *In:* V. H. Heywood, J. B. Harborne & B. L. Turner (editors), The Biology and Chemistry of Compositae, Vol. II. Academic Press, London & New York.